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ODP

Claims

We Claim

1. A method to disperse carbon nanotubes (CNTs) in a polymer matrix using a compatibilizing surfactant capable of interacting strongly with both the CNT and the polymer matrix.

2. The method of claim 1, wherein the CNTs are functionalized on their sidewalls.

3. The method of claim 1, wherein the CNTs are functionalized on their ends.

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4. The method of claim 1, wherein the CNTs are purified.

5. The method of claim 1, wherein the CNTs are not purified.

6. The method of claim 1, wherein the CNTs are single-wall carbon nanotubes.

7. The method of claim 1, wherein the mixing is carried out in a solvent.

8. The method of claim 7, wherein the solvent is removed after mixing via vacuum drying.

9. The method of claim 7, wherein the polymer nanocomposite is isolated by precipitation in a non-solvent followed by drying.

10. The method of claim 1, wherein the mixing is carried out in a blending apparatus.

11. The method of claim 1, wherein the mixing is carried out in a processing equipment including single screw extruders, twin-screw extruders and injection molders.

12. The method of claim 1, wherein the mixing is used to prepare a masterbatch followed by drawdown to necessary composition.

13. The method of claim 1, wherein the mixing is carried out at a temperature of from about 20 °C to about 400 °C.

14. The method of claim 1, wherein the amount of functionalized CNTs mixed with the polymer is from about 0.01 weight percent to about 40 weight percent of the weight of the resulting composite.

15. The method of claim 1, wherein the polymer is selected from the group consisting of poly (□-caprolactone), poly (□-caprolactone), nylon 6, nylon 66, nylon 6-10, nylon 11, nylon 12, poly (lactic acid), poly (glycolic acid), copolymers of lactic and glycolic acid, and other polyamides and polyesters.

16. The method of claim 1, wherein the surfactant is cationic, anionic, zwitterionic and non-ionic.

17. The method of claim 1, wherein the surfactant interacts with the polymer by strong ionic interactions.

18. The method of claim 1, wherein the surfactant interacts with the polymer by hydrogen bonding interactions.

19. The method of claim 1, wherein the surfactant interacts with the CNTs with strong interactions.

20. The method of claim 1, leading to polymer – carbon nanotube materials with electrical percolation ranging from 0.05 to 1.0 wt % CNT.

21. The method of claim 1, leading to randomly oriented polymer-carbon nanotube materials with hydrodynamic percolation ranging from 0.05 to 1.0 wt % CNT.

22. The method of claim 1, leading to polymer-carbon nanotube materials with strong nucleating tendencies leading to a 2 to 100000 fold increase in rate of crystallization of polymer.

23. The method of claim 1, further comprising the step of utilizing the polymer-carbon nanotube material in a drug delivery process.

24. The method of claim 1, further comprising the step of utilizing the polymer-carbon nanotube material for scaffolding to promote cellular tissue growth and repair.

25. The method of claim 1, further comprising the step of utilizing the polymer-carbon nanotube material in fiber applications.

26. The method of claim 1, further comprising the step of utilizing the polymer-carbon nanotube material in ablation resistant applications.

27. The method of claim 1, further comprising the step of utilizing the polymer-carbon nanotube material in automobile applications.

28. The method of claim 1, further comprising the step of utilizing the polymer-carbon nanotube material in high temperature, high-pressure applications.

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(i) the assembly comprises a first plurality of carbon nanotubes and a second plurality of carbon nanotubes; and

(ii) wherein the carbon nanotubes in the first plurality and the carbon nanotubes in the second plurality can be individually addressed electronically;

(b) immersing the assembly in a diazonium specie; and

(c) applying a negative potential to the assembly to cause the first plurality to essentially come in contact with the second plurality; and

(d) electrochemically reacting the assembly with the diazonium specie.

89. A product made by the process comprising:

(a) preparing an assembly of carbon nanotubes

(b) immersing the assembly in a first diazonium specie;

(c) applying a potential to the assembly in a first direction;

(d) electrochemically reacting the assembly with the first diazonium specie;

(e) immersing the assembly in a second diazonium specie;

(f) applying a potential to the assembly in a second direction; and

(g) electrochemically reacting the assembly with the second diazonium specie.

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90. The product of claims 88 or 89, wherein the carbon nanotubes of the first plurality comprise single-wall carbon nanotubes and the carbon nanotubes of the second plurality comprise single-wall carbon nanotubes.

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91. The product of claims 88, 89, or 90, wherein the assembly is a crossbar architecture of carbon nanotubes.

92. The product of claims 88, 89, 90, or 91, wherein the preparation of the assembly comprises fluid flow over a patterned surface.

93. The product of claims 88, 89, 90, or 91, wherein the preparation of the assembly comprises direct carbon nanotube growth between posts.

94. The product of claims 88, 89, 90, or 91, wherein the process further comprises connecting functionalized molecules to the assembly.

95. The product of claim 94, wherein the functionalized molecules comprise molecules that function in a capacity selected from the group consisting of molecular switches and molecular wires.

96. The product of claims 88, 89, 90, or 91, wherein the process further comprises operatively connecting molecular electronic devices to the assembly.

claims 94-129 cancelled in publication

97. A method for making a polymer material comprising:

(a) derivatizing carbon nanotubes with functional moieties to form derivatized carbon nanotubes, wherein the functional moieties are derivatized to the carbon nanotubes utilizing a diazonium specie;

(b) dispersing the derivatized carbon nanotubes in a polymer.

98. The method of claim 97, wherein the carbon nanotubes are single-wall carbon nanotubes.

99. The method of claims 97 or 98, wherein the functional moieties are chemically bound to the polymer.

100. The method of claims 97 or 98, wherein the functional moieties are not chemically bound to the polymer.

101. The method of claims 97 or 98, wherein the functional moieties are removed after the dispersing step.

102. The method of claim 101, wherein the removal step comprises heating the dispersal of the derivatized carbon nanotubes and the polymer to a temperature at least about 250°C.

103. The method of claim 101, wherein the removal step comprises heating the dispersal of the derivatized carbon nanotubes and the polymer to a temperature at least about 600°C.

104. The method of claims 97 or 98, wherein the functional moiety is operable to react with a curing agent.

105. The method of claims 104, wherein the polymer comprises the curing agent.

106. The method of claim 104, wherein the curing agent is dispersed in the dispersal of the derivatized carbon nanotubes and the polymer.

107. The method of claims 104, 105, or 106, wherein the curing agent comprises an agent selected from the group consisting of diamines, polymercaptans, and phenol containing materials.

108. The method of claims 97 or 98, wherein the functional moiety is operable to react with a epoxy portion.

109. The method of claims 108, wherein the polymer comprises the epoxy portion.

110. The method of claims 104, 105, 106, 107, 108, or 109 further comprising curing the dispersal of the derivatized carbon nanotubes and the polymer.

111. A polymer material comprising:

(a) derivatized carbon nanotubes, wherein the derivatized carbon nanotubes comprise a diazonium species moiety; and

(b) a polymer, wherein the derivatized carbon nanotubes are dispersed in the polymer.

112. A polymer material comprising:

(a) derivatized carbon nanotubes, wherein the derivatized carbon nanotubes were derivatized utilizing a diazonium species; and

(b) a polymer, wherein the derivatized carbon nanotubes are dispersed in the polymer.

113. A polymer material made by the process comprising:

(a) derivatizing carbon nanotubes with functional moieties to form derivatized carbon nanotubes, wherein the functional moieties are derivatized to the carbon nanotubes utilizing a diazonium specie;

(b) dispersing the derivatized carbon nanotubes in a polymer.

114. The polymer material of claims 111, 112, or 113, wherein the carbon nanotubes are single-wall carbon nanotubes.

115. The polymer material of claims 111, 112, 113, or 114, wherein the functional moieties are chemically bound to the polymer.

116. The polymer material of claims 111, 112, 113, or 114, wherein the functional moieties are not chemically bound to the polymer.